Incidents analysis and risk insights from concentrated solar power installations

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Concentrated Solar Power (CSP) plants represent a promising technology for supporting the energy transition through large-scale renewable electricity generation and thermal energy storage. However, their industrial deployment involves specific risks related to high operating temperatures, the use of hazardous heat transfer fluids, and the complexity of coupled thermo-mechanical systems. Previous studies on energy technology risk assessment indicate that emerging energy systems, including CSP, exhibit specific risk profiles associated with thermal processes and the properties of the heat transfer fluids employed (Sovacool et al., 2016).

At the global scale, CSP deployment remains limited but continues to expand. As of 2024, the worldwide installed CSP capacity is estimated at approximately 7.0–7.2 GW (REN21, GSR CSP 2025), corresponding to more than 110 operational plants, with significant growth driven by new projects in China and the Middle East.

This study presents a retrospective analysis of incidents and accidents that have occurred in CSP installations over recent years, based on publicly available accident databases, operational reports, and industrial feedback. Reported events are classified according to their nature: thermal, mechanical, fire related, human, and environmental. Then, analysed to identify root causes, including technical failures, organizational weaknesses, and human factors, following methodologies commonly applied in energy accident databases and industrial risk studies (Mehos et al., 2020).

The analysis identifies several recurring accident scenarios, notably leaks and degradation of heat transfer fluids (synthetic oils and molten salts), fires initiated by loss of containment of high-temperature fluids, damage or rupture of solar receivers, failures during transient operating conditions such as start-up and shutdown phases, and maintenance-related incidents. Recent studies indicate that parabolic trough technology accounts for approximately 65–70% of operational CSP plants worldwide, which has direct implications for dominant failure modes and maintenance-related risks (Achkari et al., 2025).

This work contributes to a better understanding of CSP-specific industrial risks and provides practical insights for improving prevention strategies and safety management practices. Ultimately, it aims to support enhanced industrial risk management and the sustainable deployment of concentrated solar power plants.

References

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